PB-239 705

FOREST LAKE, WASHINGTON COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

Minnesota National Guard
Minnesota Pollution Control Agency
National Environmental Research Center

January 1975

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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REPORT
ON
FOREST LAKE
WASHINGTON COUNTY
MINNESOTA
EPA REGION V
WORKING PAPER No. 100

WITH THE COOPERATION OF THE
MINNESOTA POLLUTION CONTROL AGENCY
AND THE
MINNESOTA NATIONAL GUARD
JANUARY, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

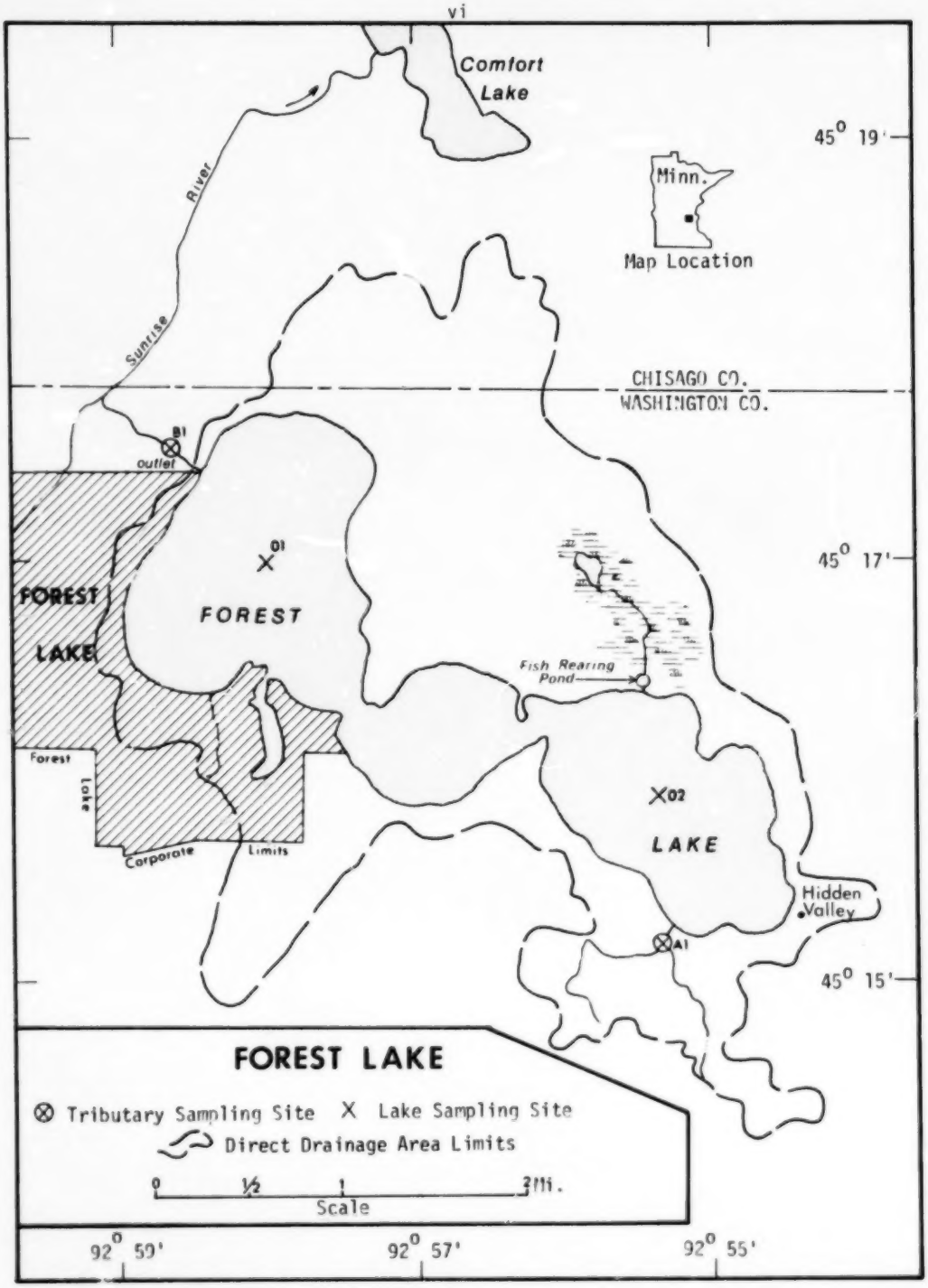
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


Comfort Lake
45° 19'
Minn.
Map Location
River
Sunrise
CHISAGO CO.
WASHINGTON CO.
B1
outlet
01
FOREST
FOREST
LAKE
45° 17'
Fish Rearing Pond
Forest
Lake
Corporate
Limits
02
LAKE
Hidden Valley
A1
45° 15'
FOREST LAKE
Tributary Sampling Site
Lake Sampling Site
Direct Drainage Area Limits
0
½
1
2 Mi.
Scale
92° 59'
92° 57'
92° 55'

FOREST LAKE

STORET NO. 27A9

I. CONCLUSIONS

A. Trophic Condition:

Survey data and the records of others show that Forest Lake is eutrophic. Of the 60 Minnesota lakes surveyed in the fall of 1972, when essentially all were well-mixed, only three had less mean total phosphorus and dissolved phosphorus, but 23 had less mean inorganic nitrogen. Of the 80 Minnesota lakes sampled, 20 had greater Secchi disc transparency, and 22 had less mean chlorophyll a.

Survey limnologists observed a moderate algal bloom in progress during August, and deep samples at station two were anaerobic at that time.

Forest Lake has a history of problems with extensive growths of submerged and emergent vegetation and frequent algal blooms (McGuire, et al., 1970).

B. Rate-Limiting Nutrient:

Results of the algal assay indicate that phosphorus was the limiting nutrient when the sample was collected. The lake data indicate that phosphorus was limiting in August and November (N/P ratios were 17/1), and nitrogen was limiting in June (the N/P ratio was 8/1).

C. Nutrient Controllability:

1. Point sources--There are no known municipal or industrial point sources impacting Forest Lake.

There was an apparent loss of phosphorus from Forest Lake during the sampling year. It is believed that the "loss" was in part due to unmeasured discharges from storm sewers serving the City of Forest Lake (McGuire, 1974) and in part to insufficient sampling of the intermittant overflow at the lake outlet. Only five outlet samples were obtained since there was little or no overflow during eight months of the sampling year, and the period of collection of the samples (March through June) probably coincided with the period of maximum runoff and storm sewer discharge.

Assuming that the sum of phosphorus input loads at least equaled the measured outflow loads, it is calculated that Forest Lake received a total phosphorus load at a rate more than twice the rate proposed by Vollenweider (in press) as "dangerous"; i.e., a eutrophic rate (see page 13). However, the measured and estimated input loads indicate a loading rate less than the eutrophic rate.

2. Non-point sources (see page 13)--During the sampling year, the phosphorus export of the unnamed stream was somewhat high as compared to Minnesota streams studied elsewhere (e.g., Lake St. Croix* tributaries).

* Working Paper No. 122.

In all, it is estimated that non-point sources contributed nearly 94% of the total phosphorus load to Forest Lake during the sampling year.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 2,251 acres.
2. Mean depth: 11.1 feet.
3. Maximum depth: 37 feet.
4. Volume: 24,986 acre/feet.
5. Mean hydraulic retention time: 5.7 years.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Unnamed tributary (A-1)	2.8 mi^2	0.9 cfs
Minor tributaries & immediate drainage -	12.0 mi^2	5.2 cfs
Totals	14.7 mi^2	6.1 cfs

2. Outlet -

Unnamed stream (B-1)**	18.2 mi^2	6.1 cfs

C. Precipitation***:

1. Year of sampling: 27.5 inches.
2. Mean annual: 27.3 inches.

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† DNR Survey map (1958); mean depth by random-dot method.
* Drainage areas are accurate within ±5%; mean daily flows are accurate within ±10%; and ungaged flows are accurate within ±10 to 25% for drainage areas greater than 10 mi^2.
** Includes area of lake; outflow adjusted to equal sum of inflows.
*** See Working Paper No. 1, "Survey Methods".

III. LAKE WATER QUALITY SUMMARY

Forest Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was collected from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was collected for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 11 feet at station 1 and 30 feet at station 2.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (11/05/72)		
Temperature (Cent.)	5.0	5.2	5.2	5.3
Dissolved oxygen (mg/l)	10.3	10.5	10.4	10.6
Conductivity (μmhos)	280	296	285	365
pH (units)	8.0	8.1	8.1	8.1
Alkalinity (mg/l)	123	128	129	131
Total P (mg/l)	0.010	0.016	0.017	0.019
Dissolved P (mg/l)	0.007	0.009	0.009	0.011
NO_2 + NO_3 (mg/l)	0.040	0.077	0.050	0.130
Ammonia (mg/l)	0.060	0.071	0.070	0.080
		ALL VALUES		
Secchi disc (inches)	4	73	95	120

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/29/72	1. Microcystis	3,020
	2. Dinobryon	868
	3. Melosira	253
	4. Cryptomonas	217
	5. Gloeocapsa	199
	Other genera	940
	Total	5,497
08/27/72	1. Microcystis	2,184
	2. Anabaena	1,084
	3. Oscillatoria	888
	4. Chroococcus	783
	5. Synura	241
	Other genera	1,627
	Total	6,807
11/05/72	1. Dinobryon	2,189
	2. Flagellates	1,849
	3. Fragilaria	830
	4. Achnanthes	566
	5. Anabaena	490
	Other genera	2,982
	Total	8,906

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/29/72	01	6.7
	02	13.9
08/27/72	01	16.1
	02	9.3
11/05/72	01	6.2
	02	10.9

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.006	0.127	0.2
0.005 P	0.011	0.127	0.9
0.010 P	0.016	0.127	2.7
0.020 P	0.026	0.127	3.3
0.050 P	0.056	0.127	3.4
0.050 P + 10.0 N	0.066	10.127	25.4
10.0 N	0.006	10.127	0.2

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the primary productivity of Forest Lake was relatively low at the time the assay sample was collected. Increasing yields with increasing levels of orthophosphorus indicate that phosphorus was the limiting nutrient. Note that the addition of only nitrogen resulted in a yield no greater than the control yield.

The lake data indicate that phosphorus was limiting in August and November (the N/P ratio was 17/1 both times), and nitrogen was limiting in June (the N/P ratio was 8/1).

IV. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Minnesota National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff month of May when two samples were collected. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Minnesota District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the nutrient loads, in $lbs/mi^2/year$, at station A-1 and multiplying by the ZZ area in mi^2.

There are no known municipal or industrial point sources presently impacting Forest Lake.

A. Waste Sources:

1. Known municipal - None
2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Unnamed tributary (A-1)	330	14.7
b. Minor tributaries & immediate drainage (non-point load) -	1,420	63.4
c. Known municipal STP's - None	-	-
d. Septic tanks* -	140	6.3
e. Known industrial - None	-	-
f. Direct precipitation** -	350	15.6
Total	2,240	100.0

2. Outputs -

Lake outlet - Unnamed Stream (B-1)	7,640

3. Net annual P loss - 5,400 pounds

* Estimated 230 shoreline dwellings (1955 U.S.G.S. map); see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Unnamed tributary (A-1)	6,650	10.7
b. Minor tributaries & immediate drainage (non-point load) -	28,500	45.8
c. Known municipal STP's - None	-	-
d. Septic tanks* -	5,400	8.7
e. Known industrial - None	-	-
f. Direct precipitation** -	21,690	34.8
Total	62,240	100.0

2. Outputs -

Lake outlet - Unnamed Stream (B-1)	54,560

3. Net annual N accumulation - 7,680 pounds

* Estimated 230 shoreline dwellings (1955 U.S.G.S. map); see Working Paper No. 1.
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs $P/mi^2/yr$	lbs $N/mi^2/yr$
Unnamed tributary (A-1)	118	2,375

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with very short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	1.0	loss*	27.6	3.4
grams/m^2/yr	0.11	-	3.1	0.4

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Forest Lake:

"Dangerous" (eutrophic rate)	0.16
"Permissible" (oligotrophic rate)	0.08

* See page 2.

V. LITERATURE REVIEWED

McGuire, John F., 1974. Personal communication (review of preliminary report). MPCA, Minneapolis.

McGuire, J. F., J. C. Cook, M. R. McCleery, and K. M. Bishop, 1970. Report on water quality investigation of Forest Lake, Washington County. MPCA, Minneapolis.

Schilling, Joel, 1974. Personal communication (lake map; water sources). MPCA, Minneapolis.

Vollenweider, Richard A. (in press). Input-output models. Schweiz. Z. Hydrol.

VII. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 27A9 FOREST LAKE

TOTAL DRAINAGE AREA OF LAKE 18.20

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
27A9A1	2.75	0.20	0.09	0.81	3.22	1.96	1.69	1.05	0.47	1.53	0.35	0.34	0.34	0.92
27A9B1	18.20	1.18	0.60	4.25	18.70	13.70	11.30	7.17	3.52	9.59	2.62	2.72	2.03	6.29
27A9Z7	15.50	1.04	0.52	3.55	13.70	11.10	9.68	5.86	2.72	7.92	2.04	2.07	1.69	5.16

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 18.20
SUM OF SUB-DRAINAGE AREAS = 18.25
TOTAL FLOW IN = 72.94
TOTAL FLOW OUT = 75.38

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
27A9A1	10	72	0.68	14	0.70				
	11	72	0.98	5	0.90	11	1.00		
	12	72	0.40	9	0.90				
	1	73	0.34						
	2	73	0.14	10	0.10				
	3	73	3.03	10	1.20				
	4	73	1.44	2	2.20	8	1.70		
	5	73	1.70	11	1.60				
	6	73	1.74	2	2.90				
	7	73	2.03						
	8	73	0.47	18	0.33				
	9	73	1.85	8	1.76				
27A9B1	10	72	0.0	14	0.0				
	11	72	0.0	5	0.0	11	0.0		
	12	72	0.0	9	0.0				
	1	73	0.0	20	0.0				
	2	73	0.95	10	10.00				
	3	73	15.50	10	5.90				
	4	73	10.50	2	16.00	8	12.10		
	5	73	11.50	11	11.00				
	6	73	11.30	2	19.00				
	7	73	13.50						
	8	73	3.41	18	2.42				
	9	73	11.30	8	11.00				
27A9Z7	10	72	3.88	14	4.10				
	11	72	5.40	5	5.50	11	5.80		
	12	72	1.94	9	4.22				
	1	73	1.70	20	1.70				
	2	73	0.82	10	0.80				
	3	73	13.00	10	4.90				
	4	73	8.63	2	13.00	8	9.90		
	5	73	9.32	11	9.00				
	6	73	9.68	2	14.00				
	7	73	11.00						
	8	73	2.64	18	1.87				
	9	73	9.35	8	9.07				

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

274901
45 17 00.0 092 58 00.0
FOREST LAKE
27 MINNESOTA

11EPALES
5

2111202
0010 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/29	12 30	0000	22.0	14.2	120	220	8.10	112	0.040	0.030	0.018	0.010
72/08/27	12 25	0000	19.5		41	240	8.30	114	0.060	0.070	0.023	0.011
	12 25	0004	19.2	8.0		240	8.35	112	0.070	0.100	0.029	0.014
	12 25	0010	18.1	7.4		238	8.30	115	0.060	0.090	0.031	0.014
72/11/05	12 20	0000			120	290	8.00	123	0.130	0.070	0.010	0.007
	12 20	0004	5.0	10.6		280	8.00	125	0.110	0.060	0.015	0.009
	12 20	0011	5.0	10.6		280	8.00	126	0.120	0.080	0.017	0.011

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/29	12 30	0000	6.7J
72/08/27	12 25	0000	16.1J
72/11/05	12 20	0000	6.2J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/30

27A902
45 16 00.0 092 55 00.0
FOREST LAKE
27163 MINNESOTA

11EPALES 2111202
5 0022 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/29	12 50	0000	22.0		112	260	8.20	126	0.060	0.040	0.017	0.010
	12 50	0018	17.5	4.2		280	7.50	133	0.040	0.040	0.024	0.010
72/08/27	12 50	0000	19.6		21	253	8.20	125	0.050	0.040	0.020	0.009
	12 50	0004	19.1	7.4		260	8.20	125	0.060	0.090	0.025	0.012
	12 50	0010	19.0	7.3		260	8.15	125	0.100	0.150	0.025	0.013
	12 50	0015	18.9	6.9		260	8.10	125	0.060	0.110	0.024	0.009
	12 50	0020	18.6	6.4		260	8.00	125	0.060	0.120	0.022	0.010
	12 50	0025	17.4	0.1		298	7.30	139	0.060	0.860	0.030	0.020
	12 50	0030	15.0	0.0		320	7.20	156	0.100	0.020	0.088	0.029
72/11/05	12 40	0000			95	365	8.10	129	0.050	0.070	0.016	0.008
	12 40	0004	5.3	10.4		290	8.10	130	0.050	0.070	0.018	0.009
	12 40	0015	5.3	10.4		285	8.10	129	0.040	0.070	0.018	0.011
	12 40	0026	5.2	10.3		285	8.10	131	0.040	0.080	0.019	0.010

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/29	12 50	0000	13.9J
72/08/27	12 50	0000	9.3J
72/11/05	12 40	0000	10.9J

J VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY DATA

STORET RETRIEVAL DATE 74/10/30

27A9A1 LS27A9A1
45 15 00.0 092 55 30.0
UNNAMED TRIB SE END OF LAKE
27 15 FOREST LAKE
I/FOREST LAKE
ST HWY 97 BRDG 2.5 MI ESE OF FOREST LK
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	12 15		0.510	1.900	0.176	0.034	0.115
72/11/05	13 45		0.900	2.310	0.198	0.040	0.100
72/12/09	13 45		0.012		2.200	0.075	
73/01/20	13 30		1.840	3.400	0.910	0.082	0.270
73/02/10	14 00		0.860	3.840	0.860	0.052	0.185
73/03/10	14 25		2.700	3.500	1.040	0.176	0.340
73/04/02	13 30		0.730	2.900	0.147	0.044	0.090
73/04/08	16 00		0.830	2.310	0.140	0.046	0.095
73/05/11	15 30		0.430	3.500	0.063	0.052	0.060
73/06/02	10 50		0.430	3.600	0.230	0.190	0.410
73/08/18	11 15		0.760	1.380	0.160	0.050	0.185
73/09/04	10 20		1.060	1.600	0.190	0.039	0.190

STORET RETRIEVAL DATE 74/10/30

27A981 LS27A981
45 17 30.0 092 58 30.0
UNNAMED OUTLFT OF LAKE
27 15 FOREST LAKE
0/FOREST LAKE
US 8 XING NE OF CITY OF FOREST LAKE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/03/10	14 05		0.160	4.100	1.600	1.335	1.500
73/04/02	13 00		0.490	3.570	0.280	0.180	0.400
73/04/04	16 00		0.252	2.800	0.320	0.100	0.220
73/05/11	16 00		0.056	3.570	0.084	0.370	0.650
73/06/02	11 00		0.015	7.700	0.330		0.410